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The Interrelationship beetween investment flows and Technology Transfer: An overview of the main issues

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THE INTERRELATIONSHIP BETWEEN INVESTMENT FLOWS AND TECHNOLOGY TRANSFER: AN OVERVIEW OF THE MAIN ISSUES*

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INTRODUCTION

1. The purpose of this paper is to examine the relationships between investment flows (IF) and technology transfer (TT) to developing countries. The main form of IF considered here is foreign direct investment. This has traditionally been the dominant form of resource and technology transfer from developed to developing countries. It is the most "packaged" form of TT, combining the provision of capital with technical know-how, equipment, management, marketing and other skills. In its "classic" form, it also entails control over the operation by the foreign investor. The significance of such "classic" investment-related transfer of technology has grown dramatically in complex, high technology industries in the advanced industrial countries. Over the past decade, after a period of relative decline, it also seems to have grown in the developing world in industrial TT more generally. 1/ This paper explores what this may mean for indigenous technology development in the developing countries concerned.

2. Equity involvement by foreign firms is only one means of transferring technology between countries. Since the 1960s, a number of other means of TT, such as minority joint ventures (with local control), licensing, turnkey projects, management contracts, subcontracting and the like, have grown in importance. 2/ Traditional overseas investors have become more willing to enter into these "new forms" of involvement in their less valuable technologies, often responding to the desire of many developing countries to establish independent industrial bases. Various technologies have matured and seen the development of new intermediaries and suppliers, specialized sellers of engineering, consultancy and equipment that have little interest in investing in equity overseas. In addition, sources of technology to developing countries have diversified as new firms and countries (generally more willing to enter into "new forms") have entered the international arena. To some extent, therefore, the traditional link between IF and TT has been loosened. It should be noted, however, that transnational companies from the developed world have been the main sources of TT in both new and traditional forms.

3. The recent resurgence in the importance of direct investments to the developing world, noted above, may be traced to several factors. The share of world innovation, production and trade accounted for by transnationals has grown steadily, making it essential for industrializing countries to establish closer contacts with them. This has become increasingly evident throughout the developing world (even the least industrialized countries), where there is widespread disillusionment with earlier strategies based on import substitution and national ownership. This general move towards "structural adjustment", emphasising market forces and fuller integration into the world economy, requires, among other things, the upgrading of technologies and skills in manufacturing industry. Investment flows by transnational firms may provide quickly and effectively the necessary technologies, skills and access to foreign markets. Moreover, with growing constriction in commercial lending and aid flows to developing countries, the financial component of IF has assumed considerable importance. Finally, several newly industrializing countries have themselves emerged as important overseas investors, with their activities proving a dynamic means of TT between developing countries. Thus, the environment for IF has changed enormously over the 1980s, and developing

countries with very different levels of development and political systems are welcoming it as a valuable input into their technological development process.

4. While IF is clearly a powerful and important mode of technology transfer, the relationship between IF and indigenous technological development is not always straightforward and linear. There are several stages between the import of technology and the development of local capabilities. A body of recent work on technological capabilities in developing countries suggests that the process of becoming and remaining technologically efficient (i.e. competitive in world markets) is complex. 3/ It often involves far more than allowing access to international technology flows (via IF or any other means), though clearly such access remains vital. The assimilation, adaptation and further development of the imported knowledge usually requires a process of building new capabilities that do not exist in developing countries. Capability development is determined, at the national level, by the policy regime on trade and industry, and by investments in skills, information flows, infrastructure and supporting institutions. At the micro level, it is the outcome of firm-level efforts to build new organisational and technical skills, a firm's ability to generate and tap information, the development of an appropriate specialization vis à vis other firms, and the striking up of linkages with suppliers, buyers and institutions. Furthermore, because of widespread externalities in the creation of skills and technologies, the social benefits of enterprise efforts to develop capabilities may far exceed the individual benefit to the firms themselves.

5. In this context, the mode of technology transfer (that based on IF and others) and its relationship to the various determinants of capability development can have important effects on the nature and pace of indigenous capability development. This paper will try to clarify some of these effects, and to place them in the setting of the rapid technological changes that are taking place in all of manufacturing industry. Given the complexity of the issues involved, it may be best to proceed in stages, addressing a sequence of questions in turn. These questions are:

- What determines the choice of the mode of technology transfer?

- Given the role of IF as a mode of TT, what determines the nature and direction of investment flows?

- What is the contribution of TT by this mode to local capability development?

- How does the acquisition of technological capabilities affect comparative advantage in trade?

- What are the impacts of recent technological changes on competitiveness in developing countries?

6. Clearly the range of issues is very large, and this paper can only highlight the main points involved. The following sections will treat each of these issues in turn.

CHAPTER I

DETERMINANTS OF INVESTMENT FLOWS

7. International investment flows are determined by a number of political, policy-related and economic factors. The significance of political stability, appropriate and transparent policies, efficient administration and the like are evident, and are not discussed here. On the economic determinants, a broad consensus has emerged on the factors that affect the content and direction of "international production". 4/

8. These factors are placed under three headings: internalization, ownership and location. Under these headings, respectively, falls the consideration of factors that decide what contractual form the investment (or transfer of technology or other intangible assets) will take, which industries and firms are likely to undertake direct overseas investment, and where these investments will be located.

9. Internalization factors: There exists a large spectrum of modes of TT according to the intensity, duration and nature of the relationships between the suppliers and buyers of technology. 5/ For present purposes, only two broad categories may be distinguished: internalized and externalized forms of technology transfer.

10. Internalized forms refer to investment-associated TT where control resides with the foreign partner (generally, but not necessarily, associated with majority or full equity ownership); these are normally associated with foreign direct investment. Externalized forms refer to all other forms, primarily joint ventures with local control, licensing and international subcontracting - these may be referred to as non-IF forms of TT.

11. The distinguishing feature between them is that in internalized TT the transferor has a significant and continuing financial stake in the success of the affiliate, allows it to use its brand names and to have access to its global technology and marketing networks, exercises control over the affiliate's investment, technology and sales decisions, and sees the affiliate as an integral part of its global strategy. Externalized forms lack one or all of these features, with repercussions on the TT process. Over time, the array of TT arrangements has diversified and particular modes have also become more flexible. Thus, the dividing lines between externalized and internalized modes are not easy to draw. 6/ Joint ventures, in particular, represent a grey area where all sorts of intermediate arrangements are possible. Thus, there is an element of simplification involved in the following discussion that should be borne in mind.

12. Four sets of factors affect the internalization choice: the nature of the technology; the strategy of the seller; the capabilities of the buyer; and host Government policy. As far as the nature of the technology is concerned, the choice of mode is determined by the inherent complexity of the technology, its speed of change, its novelty, the degree of centralisation of R&D, and whether the technology is product or process based. In general, the higher the degree of complexity (and so the greater the need for continuous personal interaction of transferor and transferee), the faster the speed of change, the

newer and more valuable the technology and the more centralized the R&D on which it is based, the more TT will take internalized forms. Process technologies are, however, more readily transferable in externalized forms, with even the latest vintages available from engineering firms and equipment suppliers. Product technologies (machinery, electrical, transport and electronic) are more demanding of skills and less available, at least in their latest versions, at arm's length.

13. The seller's strategy is determined by the size of the firm (larger firms prefer internalized modes for their valuable technologies and are more capable of handling transnational operations); product concentration (more diversified firms are more willing to externalize non-core technologies); dependence on proprietary brand names (higher valued names call for more internalization); the firm's experience of TT (less exposure to international operations induces more externalization); and individual strategic considerations, which are often influenced by the corporate culture of the home country of the seller (countries that are new entrants to the international investment scene have tended to have firms that favour externalized modes).

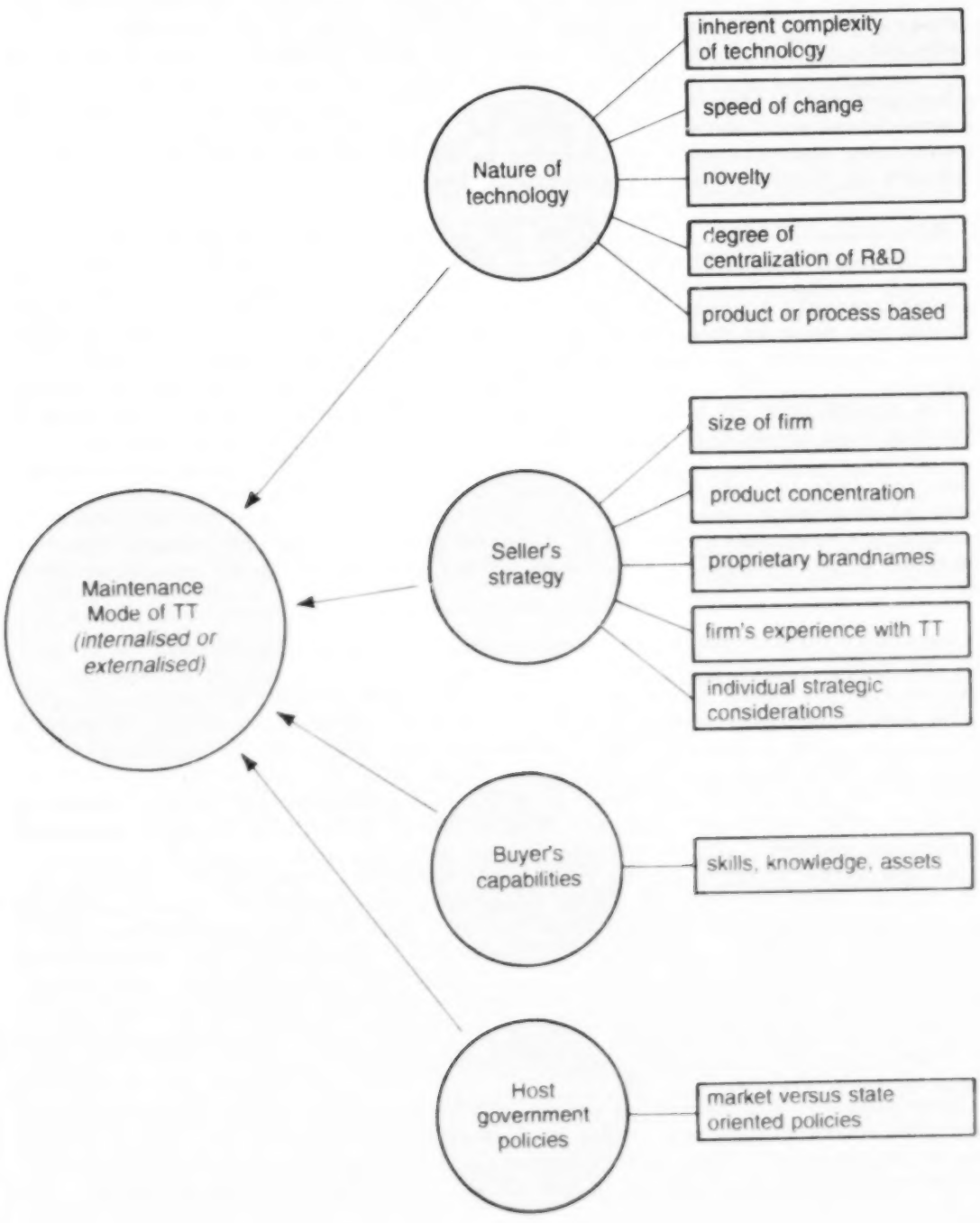
14. Buyers' capabilities have a mixture of effects on the preferred mode of TT. On the one hand, a more capable buyer needs fewer elements to make the transfer successful and implies less effort and cost to the seller; thus, there is less need to internalize the transfer on these grounds. On the other hand, a more capable buyer poses a greater potential threat to the supplier, especially if it is oriented to world markets; unless it has some technology to offer in return, therefore, the seller may prefer internalization, or sale at very high prices and with many conditions attached. In these cases, the outcome is usually settled by a bargaining process, and is affected by the skills, knowledge and assets that the parties can muster.

15. The above conditions are based on the assumption of freely functioning markets. In developing countries, most Governments seek to intervene in the TT process to lower the costs and improve the conditions for their enterprises. Until recently, the thrust of government policies has been to increase externalized TT in order to boost local capability development, often behind high protective barriers. The shift to more market-oriented policies has reduced this bias in many countries, and the emerging tendency is to leave the choice to the parties concerned. Some Governments still confine internalized TT to high-tech or export-oriented activities, while others encourage internalized TT over other forms because of associated capital flows and the commitment entailed.

16. The choice of the mode of TT can be visualised in a simple diagram (figure 1). This diagram sets out all the factors affecting the choice as discussed above, though it does not attempt to show the interrelationships between them.

17. In general, internalized technology flows can be a very efficient means of transferring a package of capital, skills, technology, brand names and market access to developing countries. The economic value of such transfer depends, however, on the costs and effects of alternative means available of effecting the transfer. For some frontier technologies, internalized TT may be the only mode possible; even if the technology were for sale,

Figure 1
DETERMINING THE CHOICE OF MODE OF TT



internalization may be the most efficient way of transferring the knowledge and skills involved. If the technology were changing rapidly, internalization would again be preferable, as also if exports based on the technology required an established brand or a vertically integrated production structure across several countries. Even for simple technologies, if the recipient lacked the complementary skills and organization to utilize them efficiently, internalization would be the best mode. However, foreign investment does have its costs, and profits are realised on the total value of the package transferred. If the host country already has some elements of the package, it may be cheaper to buy the missing elements only. In general, the more standardized and diffused the technology, and the more capable the buyer the more economical will externalized modes be. Even for more complex technologies, the existence of learning benefits and externalities may tilt the choice in favour of externalization. These issues are taken up below.

18. Ownership factors: If all firms had access to the same technology, skills and markets, there would be no reason for direct foreign investment, and capital flows would take the form of portfolio investments or loans. No firm would be able to bear the extra costs of operating in foreign countries if it did not have an "ownership advantage" over its competitors. The growth of direct investment is thus dependent on the existence of some intangible advantages that accrue to particular firms and that can be transferred abroad at a low enough cost to make such investments profitable. These intangible assets are also those that allow some firms to grow, and so give rise to concentrated industrial structures within given countries. These are similar to the "barriers to entry" to new competition that are the basis of much industrial economics, except that the barriers that give rise to overseas expansion are more characterized by transferable firm-specific assets like technological and marketing advantages rather than plant-level economies of scale.

19. Ownership advantages arise in technology and marketing because in both firms can create proprietary assets that competitors are denied access to, either because of legal (intellectual property) protection, or because they are the result of investments in specific skills, knowledge and organizational capabilities. The scale of these investments may create entry barriers. However, the more important barriers may arise from the nature of the "learning" and innovation process, in which new knowledge and skills reside in particular individuals and groups. Others cannot gain these without investing in a similar process. It is the ability to generate such intangible assets that allows firms to grow within and across countries. Physical economies of scale become important only if large firms (and transnational) have privileged access to capital markets - they often do, but this is a permissive rather than a driving force in international investment. Similarly, the very fact of being transnational can give rise to advantages (of communication, knowledge, supply sources, organization and so on) that facilitate further IF, but the exploitation of these advantages depends ultimately on the continuous creation of a competitive edge in technology and marketing.

20. Technological and marketing advantages thus explain which industries, and within them which firms, are likely to undertake significant IF. A large body of empirical research shows that transnational activity is closely associated with industrial propensities to invest in R&D and product differentiation.

Firms that lead IF are large enterprises with strong technological and brand name assets; the bulk of the world's enterprise R&D is accounted for by a relatively small number of transnational firms. 7/ The national ability to foster these activities also explains which countries produce most IF, i.e. those that have the human capital and technological resources, and supporting infrastructure, to have a large number of competitive firms. 8/ This is not to deny that individual firm strategies are important. Clearly they are. Firms have their own perceptions of their competitive advantages and how best to enhance and exploit them. In this, as in technology, they have their own "learning" trajectories, influenced by chance, history and experience. However, there are sufficient common elements that allow generalizations about industrial and national determinants to be made with considerable confidence.

21. While technology and marketing (and the associated skills and organisational structures) are the engines of growth of IF, the process of investment per se does not imply that all technologies and skills get equally diffused internationally. Transnational firms may not deploy their latest technologies, or set up innovative functions, in all the locations where they produce abroad. The technolcgical and other functions that are transferred to particular locations depends on the factor endowments and other conditions there (see below), but the nature of the innovation process also affects the process of technology and innovation transfer. In the earliest stages of the product development cycle, it is imperative to have intense interaction between research, production and marketing functions within firms, as well as close linkages with sophisticated science and technology infrastructures and supplier networks. 9/ As transnationals grow better established abroad, the innovation process does extend itself to other locations and the product cycle does shorten. But the transfer of innovation, because of its skill and linkage requirements, tends to be confined to a few other advanced countries, and the home country still remains the main base of innovation even in the most internationalized of firms. 10/

22. As far as developing countries are concerned, some newly industrializing economies (NIEs) are benefiting from the shortening of the product cycle, because they have the complementary factors necessary to make new, advanced technologies work efficiently. Other countries are still at the lower end of the cycle, and technological trends may be keeping them there. These issues are discussed in the following paragraphs.

23. Locational Factors: The choice of where to place an investment abroad is determined, on the host country side, by market size, factor endowments and costs, infrastructure, trade policies and other policies that affect macroeconomic stability, competition, entry and exit, ownership, employment and so on. Policies are important influences on the attractiveness, risk and cost of each location, and tend to be particularly significant in developing countries. They are not, however, directly germane to this paper, and will be ignored below. On the side of the investor, location is affected by the nature of the technology concerned, individual corporate strategies and perceptions of risk and reward. Again, only the technology factor is relevant here and will be discussed below.

24. Market size has an obvious effect on the location of domestic market-oriented investments, whether or not these are stimulated by

protectionist policies of the host Government. While protection creates an obvious need to establish local production, even in small markets and on inefficient scales, large markets have an independent attraction even under free market conditions. In activities like consumer goods or customized capital or intermediate goods, where close interaction with the buyer is important, many firms regard a production presence as a competitive advantage. Even for export-oriented projects, a large host country market can be important if it allows the investor to sell a proportion of its output locally or if it favourably disposes the Government to allow it to set up a local market-oriented project.

25. Factor endowments include a number of things: the availability of natural resources (for extractive and processing investments); "raw" labour costs; the availability of skills at low costs and at various levels; the quality of the supporting technology infrastructure (standards, quality assurance, metrology, information and technical services, research laboratories); and the efficiency of the relevant suppliers of inputs and services. The first does not need explanation. The second and third are also clear, but it needs to be stressed that cheap "raw" labour is a locational attraction in only the simplest of activities. Even in garment assembly, a very low technology entry-level activity, a base of worker literacy and trainability, and of supervisory and technical skills, is essential for export-oriented investments. In more complex activities, the need for diverse and sophisticated skills is much greater. If production has to be internationally competitive (as it increasingly does under more market-oriented strategies), technologically demanding activities will gravitate to locations that can provide the skills, or at least have the capability to acquire them quickly (and at low cost to the investor). Some high-level skills can be imported, but longer-term cost competitiveness depends on a local supply of most relevant technical and managerial skills.

26. The need for a good technology infrastructure rises with the sophistication of the technology involved, especially in engineering and other activities where a high level of precision is involved. 11/ Many large investments can internalize the necessary technological activities, or draw on the parent company for the services needed (though this may be expensive). Smaller investments may be handicapped by the lack of technical services that are taken for granted in developed countries and the NIEs. Similar considerations apply to the supplier system. In many process industries, there is little need to depend on suppliers of components and specialized inputs. In engineering industries, however, efficiency depends on specialization and a dense network of linkages between subcontractors, suppliers and service firms. In particular, where "just-in-time" inventory systems are becoming necessary for competitiveness, a highly developed supplier network is a precondition for foreign investment. The quality of the supplier network is also dependent on the efficacy of information flows and the services provided by the technology infrastructure. A dynamic financial system is also essential to industrial functioning.

27. These factors related to skills, technology and suppliers can be broadly labelled the "technological capabilities" of the host economy. The level of such capabilities influences the nature of inward investment and TT (i.e. which activities and technologies are attracted), and also the results of such

investment (i.e. how well the technologies are absorbed, utilized and further developed). The relevance of the physical infrastructure to all this is clear. Modern industry, especially if it is to compete in world markets, needs excellent infrastructure. More and more activities need constant contact with the outside world, both in physical inputs and outputs and in information and personal contacts.

28. The locational factors just described can be laid out in a clear form in table 1. The nature of the effects of each factor is shown in the last column.

29. These locational factors have to be put in the context of current technological changes. The acceleration in the process of technical change is amounting to what is in many analysts' view a new technological revolution. From this revolution will emerge massive changes in competitiveness, location of activity, skill needs, work organization and technology-support needs. While the ramifications of these changes are still difficult to define, and the process will take a long time to work itself out, some tendencies of relevance to TT to developing countries may be tentatively noted.

30. First, industry is becoming increasingly globalized, with countries specializing in segments of industries rather than entire industries (e.g. engines for cars rather than the whole automobile); the globalization process is being led by transnational from the developed countries, and it is becoming increasingly difficult in many technology intensive industries to develop independent dynamic comparative advantage. 12/

Table 1
Locational factors affecting investment flows

On the side of:	*Locational factors*	*Effects*
A. Host country	(a) Market size	Proportional relationship
	(b) Factor endowments	
	Natural resources	Mainly for extractive and processing investments
	Raw labour costs	For very simple activities
	Skill availability	Increasingly important for all activities
	Supporting technological infrastructure	Directly related to degree of sophistication of technology
	Suppliers' reliability	Increasingly important for transfer of organizational technologies
	Efficiency of services	
	(c) Infrastructure	Proportional relationship
	(d) Policies	Conditioned by policy regime
B. Investor	(a) Nature of technology	
	(b) Corporate strategy	
	(c) Perception of risk and reward	In legal terms it will be related to the intellectual property rights regime

31. Second, international investments by the advanced industrial countries are increasingly focusing on technology-intensive activities, while the lower technology segments are being taken over by firms from the NIEs.

32. Third, even low-technology activities are being affected by technological progress, so that competitive production requires higher levels of skill, specialized training and flexibility.

33. Fourth, because of these forces (and assuming favourable government policies), it is likely that medium to high technology investments in the developing world will increasingly concentrate in locations that are already industrialized, have good infrastructure, and have developed a base of technological capabilities. Lower technology investments will go to less industrialized areas, but even here they will concentrate on locations with relatively high levels of human capital and infrastructure. 13/

34. Fifth, the preconditions for attracting higher "quality" foreign investment can only partially be created by the investors themselves. The bulk of the work will have to be done by the countries themselves, in terms of investing in education, technology, and the like, and perhaps by intervening selectively to promote infant industries that embody their dynamic comparative advantage (see below).

35. Finally, because of the increasing competition for IF and a widespread move to liberal economic policies (the entry of Central and Eastern European countries will become a major factor here), it will be imperative to have an investment regime that is stable, welcoming, transparent and efficiently administered. An important part would be a strong intellectual property rights regime. It is widely accepted that intellectual property protection per se is a valuable stimulant to innovation and TT in only a few industries (pharmaceuticals and software being the prime examples), where the results of expensive innovation are easy to copy. In other industries, the proprietary nature of the skills and knowledge involved are the most important means of protecting intellectual property. Nevertheless, the "signalling value" of the intellectual property regime has become extremely important in recent years. In general, countries that seek to attract technology-intensive foreign investments also offer strong protection (though there are exceptions).

CHAPTER II. CONTRIBUTION OF INVESTMENT FLOWS TO DOMESTIC TECHNOLOGICAL CAPABILITIES

36. It was noted at the start that there are several steps between the transfer of a technology, in the sense of providing the equipment, instructions and blueprints, and its effective absorption, deployment and subsequent upgrading. The same technology may be used at widely differing levels of efficiency in different locations, and its productivity may decline in one place while it rises sharply in another. Much of these differences can be traced to differing levels of technological capabilities. These capabilities are the skills, technical knowledge, organizational structures, and external (to the firm) linkages necessary to master an imported technology, adapt it to local factor and market conditions, upgrade it to maintain competitiveness in world markets and improve on it to allow diversification. 14/

37. The initial transfer of a technology cannot lead to efficient operation if the necessary skills and technical and managerial know-how are not generated - there are many "implicit" elements in technology that need a long period of learning by the recipient. This learning may be partly the automatic result of production experience, but in most activities it will also require purposeful investments by the firm in training, search for new technical and other knowledge, experimentation, and developing the organizational capacity to create, communicate and diffuse knowledge internally. In advanced industrial activities, the absorption of new technologies will also involve the undertaking of formal research and development. 15/ There are many levels of capabilities that can be acquired in a given technology, with varying inputs of local, as opposed to foreign, knowledge and skills.

38. In developing countries, many of the low-level absorptive skills that are taken for granted in the developed world may be lacking, because the complexity and scale of new technologies will tend to be far more in advance of existing technologies. Even mundane activities like plant layout, quality assurance, maintenance and process optimization may call for substantial capability building. Thus, the acquisition of technological capabilities may often entail, apart from in-house efforts by firms, broader social investments in education, training and the provision of information. In addition, capability building by firms does not usually take place in isolation. In most activities there is a need for a great deal of interaction between firms and with technology service and infrastructure institutions like standards laboratories, extension services, research centres, quality control centres, and similar support institutions. Thus the promotion of linkages and the development of institutions to undertake activities beyond the scope of individual firms becomes a vital part of capability development.

39. Since the development of capabilities is analogous to investment in physical facilities, taking time and involving cost, risk, and uncertainty, it is highly sensitive to the incentive environment facing firms. Some capability building is essential to merely operationalize a new technology and will occur in all regimes. The achievement and maintenance of international competitiveness, however, calls for much more. The trade and internal competition regime thus has a powerful impact on the extent and direction of

capability building efforts undertaken. An environment that insulates firms from competition, especially world competition, has been found to promote less, and less efficient, technological development.

40. However, given the time, costs and external support needed by firms to master complex technologies, a full exposure to world competition may abort the learning process altogether, preventing a deepening of the industrial structure. 16/ The extent to which technological development can proceed with such exposure depends on the level of skills already present, the complexity of the technology involved and the level of indigenous mastery of the technology aimed at. In very simple industries, given a base of local manufacturing know-how, capability development may be best promoted by free trade backed by some institutional support. In more complex activities, a high reliance on foreign investment and skills can shorten the learning period, and also relieve the financial stress on local enterprises (which do not have the "deep pockets" of transnational firms). This may, nevertheless, have other repercussions, that are noted below.

41. Where a developing country desires to enter heavy, complex industry with a large element of local technology, there may be a strong case for promoting and protecting infant industries during the learning period. Given the deleterious effects of protection, however, offsetting measures have to be undertaken, e.g. limiting the duration of protection, and forcing firms to compete internally and to enter world markets quickly. This was the strategy pursued by the larger East Asian NIEs, and earlier Japan, to enter heavy industry under national ownership. 17/ It must also be remembered that most of the presently industrialized nations also protected and promoted entry into heavy industry in the last century and the earlier part of this century, in a period with much more natural protection (from transport costs, differing standards, procurement practices, etc.). 18/

42. What role does foreign technology play in local capability development? As with any make/buy decision, the choice of whether to import a technology or to create it internally has to be decided on its economic merits: the direct costs and returns, as well as the externalities and longer-term dynamic benefits. The decision is not a black-and-white one, in the sense that there are innumerable variations possible on how much, and what stages, of particular technologies are imported or created locally. Moreover, local efforts do not have to "reinvent the wheel" even if they do not utilize formal imports of technology - much of such efforts rely on imported equipment, information (via journals, visits, and so on), and reverse engineering. Given the level of local technological capabilities, therefore, the need for formal imports will rise with the sophistication of the technology: some technologies can be mastered relatively easily by importing equipment; some will need discrete inputs or licensing; and some will need (or only be available under) equity participation by the technology suppliers.

43. The relationship between local capability building and technology imports is therefore partly complementary and partly competitive. 19/ Inputs of knowledge from countries that already have a technology are clearly necessary to launch local efforts to master it. But too passive a dependence on imports of know-how can stifle the development of local capabilities, with three deleterious effects: first, the cost of absorbing and deploying a technology

is higher if local capabilities are weak; second, the adaptation and further development of a technology, and its beneficial externalities, are reduced if locals are unable to undertake these tasks; and, third, the "quality" of investment-related technology imports cannot be raised if the local economy is not able to offer higher levels of skills and technological effort. There is thus a clear policy choice to be made on the extent of technology imports. Whatever the choice, the developing country has to invest in skills, R&D, infrastructure and support systems, as well as providing a conducive policy environment for technological effort, in order to promote industrial and technological development.

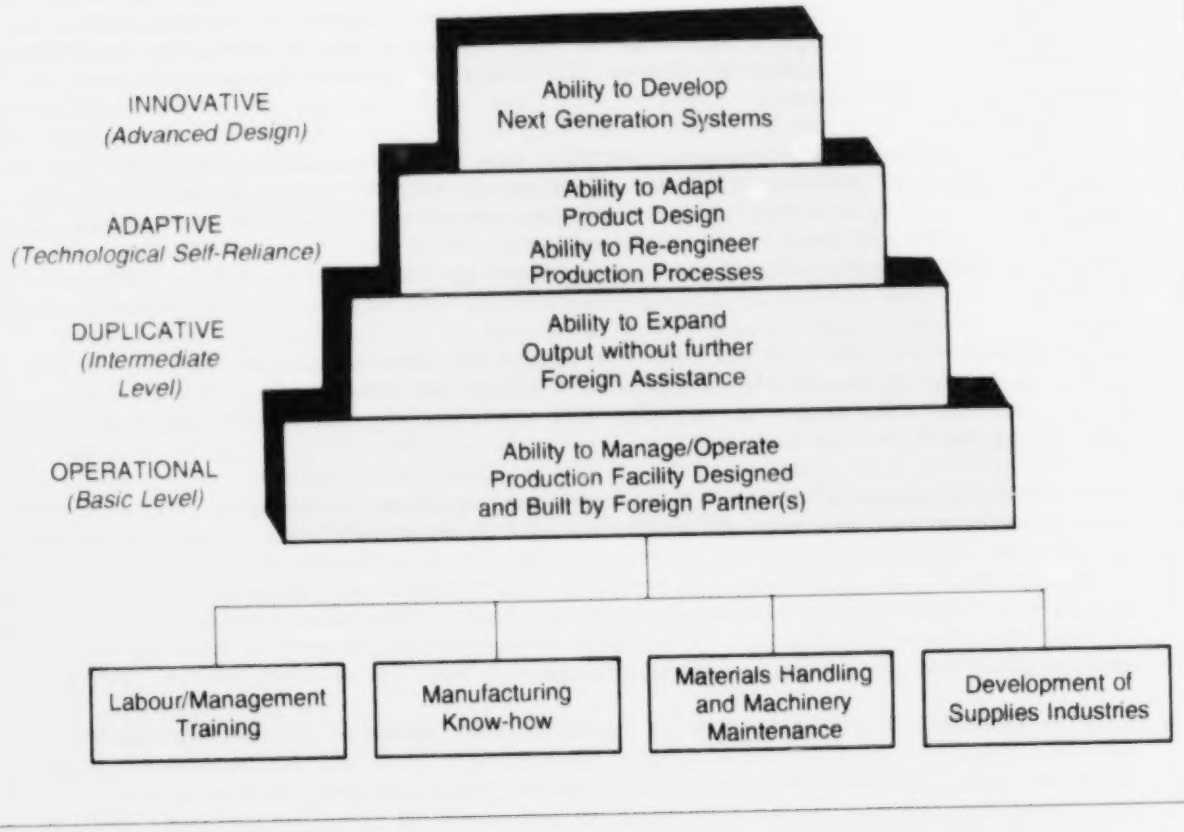
44. This applies also to countries that are at the beginning of their industrialization process and have rudimentary technological bases. These countries can only attract FDI in the simplest of assembly and processing activities to start with. At the same time, their own capabilities are too meagre to permit independent entry into more advanced industrial activities. At this stage the inflow of foreign technology and skills via FDI will generally be more complementary than competitive to indigenous capability development. A sustained move up the ladder of industrial activity would still necessarily involve investment and effort by the country itself in skills and in other means to promote the institutional and technological absorptive base of the economy.

45. At more advanced stages of development, however, when local capabilities have developed but are not at the level of the advanced industrial countries, the choice regarding the form of technology import becomes more important, and possibly more difficult. At this stage, the competitive aspect of technology import and indigenous technological effort has to be taken into account, even if the country concerned has to rely on advanced countries for the import of innovations and very complex technologies.

46. A useful way to analyse this "make or buy" decision on technology is to divide capabilities into four levels (see figure 2). At the bottom are the simplest ones, needed for operating a given plant: these involve basic manufacturing skills as well as some more demanding troubleshooting, quality control, maintenance and procurement skills. At the intermediate level are duplicative skills, which include the investment capabilities needed to expand capacity and to purchase and integrate foreign technologies. Next come adaptive skills, where imported technologies are adapted and improved, and design skills for more complex engineering learned. Finally come innovative skills, based on formal R&D, that are needed to keep pace with technological frontiers or to generate new technologies. Simplified as these categories are, they are helpful in illustrating the path of capability development within and across technologies.

47. The transfer of foreign technologies may help progress at any or all of these levels, depending on the considerations noted above. The advantage of investment-related, internalized forms of TT over others lies, as noted earlier, in the long-term commitment of the foreign partner to the success of the project, its ability to provide many of the elements of the package needed to operationalize new technologies and its access to world class technologies and markets. At the lowest level, therefore, foreign investment may be one of the most efficient ways of transferring technology. Since all technologies

Figure 2
LEVELS OF TECHNOLOGY TRANSFER DEFINED



need adaptation and improvement to keep them competitive, foreign affiliates, with their base of high-level management and technical skills, tend to be in the forefront of such activity in developing countries. In addition, transnational firms have the experience of other affiliates in the developing world to draw on, and can shift knowledge and personnel across countries to help with the upgrading of local capabilities.

48. As capability development progresses to the fourth level, where local innovative efforts become viable, there arises the possibility of a conflict of interest between the developing host country and the foreign investor. There are strong reasons for the investor to keep innovative work centralized at home or in a few developed countries, for reasons noted above, and even the more advanced NIEs get essentially adaptive R&D investments from transnationals. 20/ At the same time, it is economically efficient for a number of the more advanced developing countries to invest in higher-level technological activity, and the success of exports of sophisticated products based on local R&D (as in cars, televisions, aircraft or machinery) testifies to their capabilities to absorb the relevant technologies and further develop them on their own. Transnationals tend to transfer the results of their R&D rather than the innovative process itself, at least until fairly high levels of development, whereas the sustained technological growth of developing countries calls for increasing investments in local innovation. There is then a case for restricting reliance on internalized forms of TT and the boosting of local R&D based on other forms of TT and indigenous research.

49. At the same time, it should be remembered that there is considerable flexibility in investment-related forms of TT, and a developing country may be able to induce a higher level of innovative activity if it can offer the right skills and infrastructure. In addition, a foreign presence may have beneficial externalities by stimulating competition, helping local suppliers and providing linkages with international centres of technological activity. Where economies of scale in R&D are high, it may not be advisable to "go it alone" in innovation. The increasing trend to strategic alliances among the largest firms suggests also that local firms should strike deals with technology leaders that allow them some access to frontier technologies.

50. It is not possible to generalize on the optimal policies for choosing the extent and form of reliance on foreign technologies. Much depends on the existing and evolving levels of local skills and capabilities, on the nature of the technologies concerned, and on the alternative means of access available. Given the international conditions, what is desirable for a country like the Republic of Korea may be inappropriate for Mexico and simply out of the question for a least developed country. The Republic of Korea has managed to reach many technological frontiers with relatively low reliance on internalized TT, by dint of its investments in human capital, institutions and technology, and by a combination of selective protection and the promotion of large domestic firms. 21/ Few other countries have managed this combination. The correct choice on TT thus depends on the choices made earlier on trade and industrial policies and on investments in capabilities.

CHAPTER III. TECHNOLOGICAL CHANGE AND COMPETITIVENESS

51. It is now widely accepted that competitive advantage in world markets for manufactures is determined only to a minor extent by factor endowments (in the neoclassical sense of given stocks of labour and capital). 22/ Other factors, related to technological leads and lags, economies of scale and product differentiation, and the location decisions of transnational corporations have a far more powerful impact. Much of the empirical research on trade patterns supports the "neo technology" version of comparative advantage theory.

52. Apart from obvious advantages created by the possession of natural resources, factor endowments in a static sense affect trade patterns only in activities where technologies are simple, well diffused, small-scale and easily transferred and absorbed (e.g. garment sewing). In most industries (including the design of garments) these conditions do not apply. Where technologies are difficult, specialized skills are required, and complex organizations are needed to handle large scales of manufacturing, sales or research, the ability to master these before competitors becomes the determinant of comparative advantage. This ability is in turn determined by government policies on trade and industry, investments in capabilities (human capital and technology), and the development of support institutions. 23/

53. While the significance of technology factors is evident in explaining the trade patterns of advanced industrial countries, their role in developing countries is not so obvious. After all, the developing world accounts for a small fraction of the world's R&D expenditures (about 5 per cent), and the most successful exports of the NIEs are not based on their own innovations. This interpretation is based on a view of technology as "major innovation", where a lead emerges from a new process or product that no one else has. The correct scope of technological activity is, in fact, much wider. 24/ It includes "minor innovation", the steady stream of small incremental improvements which accounts for the larger share of productivity increases in the developed world and which explains much of the cost, design or quality advantages that drive competitive advantage. It also includes, for developing countries, the gaining of "technological mastery" and the assimilation and adaptation of a given technology, which for the firms involved involves just as much technological effort as innovation - and often involves formal R&D. In combination with factor endowments (lower wages), the gaining of mastery explains much of the dynamic comparative advantage of developing countries. Differences between countries are then explained by differences in their capabilities to master technology, and in their policy regimes (including the granting of infant industry protection) that promote national capabilities.

54. Technology thus has as large a role to play in determining competitiveness in developing countries as in developed countries. Within technological activity, the relative roles of simple learning by doing, experience-based engineering activity, more disciplined search and experimentation, and formal R&D depend on the activity and the stage of industrial development concerned. There is a steady progression up the ladder with industrial development, with more formal technological activities taking precedence as the informal ones become more routinized and widespread. As the complexity of the industrial sector rises, increased inter-industry

specialization becomes imperative and greater interaction among firms, and with technology institutions, becomes necessary: thus, the technological determinants of comparative advantage encompass mechanisms for technological diffusion, information flows and infrastructure support for training and research.

55. The impact of technical progress on the comparative advantage of developing countries is pe vasive. 25/ All industrial technologies are subject to constant change and improvement, and the latest wave of information technology innovations are affecting practically every industry. This is affecting their locational advantages in developing countries, as discussed in the section on the determinants of technology flows. The competitiveness of any particular location is dependent on several factors, the nature and relative significance of each varying on the basis of the technology involved:

- Its ability to furnish the minimum levels of skills (technical and managerial) that the efficient operation of the new technology requires; as technologies become more complex and science-based, this calls for higher levels of training in a wider spectrum of subjects;

- Closely related to the above, its ability to provide a labour force that is productive, flexible and low-cost, one that is able to conform to very demanding quality standards, operate across traditional work categories, and constantly be retrained in new skills and attitudes;

- Its supplier system, to meet the needs of evolving "just-in-time" production techniques, and the support needed for information-based processes;

- Its technological infrastructure, that feeds into the technological work of individual enterprises and promotes information flows within the country as well as into it;

- Its ability to provide the physical infrastructure needed to keep the new activities running efficiently at world levels of efficiency, including transport of goods and services, communications, finance and information.

56. Until now, the impact of these factors has been unequal across the developing world. Countries that have built up a certain level of technological capabilities and adopted appropriate policies have gained far more than less industrialized countries. There is a spillover of activities evident from the more to the less advanced developing countries, but again the process is uneven and localized. At each stage, progress is determined by the ability to absorb technologies efficiently and by the nature of government policies.

57. Policies play a dual role. First, they directly affect the inflow of technology, by direct investment and by other means. Here, the widespread liberalization that is sweeping the developing world means that, macroeconomic considerations apart, there will be fewer differences in the policy factors that attract investment flows. Second, policies affect TT indirectly, via education, training, science and technology, competition, trade orientation and so on. The pace and nature of technological progress are such that these

indirect influences on TT and technological development will be more important than direct ones in the foreseeable future.

58. There are thus close interlinkages between technical change, technology flows, domestic capability development, competitiveness in trade, investment flows and government policies. These linkages have grown closer because of the internationalization of production and the growing significance of trade. Technology generation is now based on global considerations, despite the concentration of innovation in a handful of countries and companies. Developing countries are increasingly conscious of the need to participate fully in world trade and production. The way that they can participate depends on the competitive advantages that their past investments in capabilities gives them, and the dynamic advantages that they can build in the future by policies on incentives, skills, technologies, infrastructure and the relevant institutions.

59. The role of investment-based technology flows is increasing rapidly, and, given the nature of the current technological revolution, is bound to grow in the future. This does not mean that domestic effort at capability development becomes less important. On the contrary, the attraction of technology flows of higher quality necessarily involves continued investments in national technological capabilities (and the accompanying developments in managerial and organizational skills). And the development of national capabilities also requires a strong indigenous industrial sector that is complementary to the foreign-owned sector. The precise lines between these will vary from one country to the next, by their history, location, size, ideology, and capabilities themselves. What will be common will be the interlinkages between indigenous capability development, TT, investment and competitiveness, all depending on the adoption of the right policies.

CHAPTER IV. CONCLUDING REMARKS

60. The issues that arise for developing countries essentially concern the policies that they must adopt in order to benefit from emerging technologies and the potential for technology transfer by direct investment and other means. The world today is very different from that in which most industrial strategies were formed some three to four decades ago. This realization is leading to massive changes in most developing countries. In a reaction to over-interventionist, inward-oriented, public-sector-led industrialization, they are generally switching to policies that are more market-oriented, open to trade and foreign investment, and reliant on private enterprise.

61. As far as transfer of technology and investment flows are concerned, the speed of technical change and the desire to become trade-oriented mean that developing countries will encourage both, but with a heavier emphasis on investment-related inflows of technology and skills. Under ideal circumstances, foreign investments can become the engine of dynamic comparative advantage in developing countries, providing the "missing factors" to their industries in accordance with their emerging competitiveness. The main policy issues confronting these countries are how to provide a stable macroeconomic environment, a conducive regime for foreign entry and liberal trade policies, with investments in human capital and technology support institutions to encourage continuous upgrading of industrial activities (what the 1991 World Development Report of the World Bank calls "market friendly policies").

62. This reading of policy issues may be somewhat disingenuous. While more market-oriented policies will benefit the industrialization process, and many past interventions have been misguided, the positive role of government interventions (apart from "market friendly" ones) should not be dismissed. Many markets in developing countries, and in international capital and technology flows, do not work perfectly. 26/ The presence of externalities, information gaps, uncertainty, public goods, risk aversion and so on lead to market failures, when lack of intervention may lead to sub-optimal results. This paper has suggested that the ultimate determinant of industrial success, regardless of the forms of transfer of technology, is national investment in capability development. This embraces investment in education and training and the physical and technology infrastructure, and the development of supporting investment (with which most analysts would agree). It could also include policies and measures that promote the development of infant industries, the selected encouragement of externalized purchase of foreign technologies and the focusing of education, training, technologies and industrial efforts on areas of future comparative advantage (what is loosely referred to as picking the winners). The experience of the newly industrializing economies illustrates that different policy measures can lead to different results in terms of industrial depth, efficiency and indigenous technological capabilities. 27/ The real policy issues then are the correct extent and nature of interventions that remain in a more liberal economic environment.

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Notes

1/ In 1990 IF to the developing world reached $32 billion, with a growth rate of 22 per cent per annum in 1986-1990 (compared to 4 per cent per annum in 1980-1985). However, the share of IF going to developing countries fell from 25 per cent in the early 1980s to 17 per cent in the latter 1980s, as the flows concentrated increasingly on the developed world. In relation to international payments for technology in the form of royalties and fees, while global IF grew at similar rates until the 1980s, they began to diverge thereafter, with investments growing one and a half times faster than royalties for the world as a whole, and nearly two times higher for the developing countries. See UNCTC, 1992.

2/ On classic and new forms of foreign involvement, see C. Oman, 1984, and Oman et al., 1989. UNCTC, 1987, and Vickery, 1986, provide analyses and data on different forms of technology trade.

3/ See Dahlman, Ross-Larson and Westphal, 1987, Enos, 1992, and Lall, 1990, 1992.

4/ See Dunning, 1988, for a succinct and comprehensive review.

5/ Only formal modes of TT, involving a contractual relationship, are considered here. There are many other modes, such as migration of skilled personnel, publications, symposia, visits, and so on, that often contribute to TT, but these are ignored here. The transfer of "embodied" technology in the form of sale of equipment, if not accompanied by other contractual arrangements, is also excluded. For a detailed analysis of the various modes of TT see UNCTC, 1987, and Oman, 1984.

arrangements, is also excluded. For a detailed analysis of the various modes of TT see UNCTC, 1987, and Oman, 1984.

6/ For this reason, it is not possible to quantify technology flows by these categories. Data on royalty receipts and payments are available for many countries, but the bulk of royalty payments are for internalized TT, from one part of a transnational enterprise to another. See Vickery, 1986.

7/ See UNCTC, 1992, chapter VI.

8/ See Dunning, 1988, and Porter, 1990.

9/ See the classic article on this by Vernon, 1966, and its updating in Vernon, 1979.

10/ See Porter, 1990.

11/ On the differences that arise from the nature of the technologies, see Pavitt, 1984.

12/ See UNCTC, 1992.

13/ This does not mean that the least developed countries cannot improve their positions (see below); it only implies that under present circumstances there is likely to be increasing differentiation between developing countries as technological factors exert increasing pressures on location in a more competitive world.

14/ For a more detailed exposition see Enos, 1992, and Lall, 1992.

15/ See Cohen and Levinthal, 1989.

16/ See Lall, 1992, and OED, 1992.

17/ See ibid. and Amsden, 1989, Pack and Westphal, 1986, and Wade, 1991.

18/ See Vernon, 1989.

19/ See Chesnais, 1986, Lall, 1992, and Porter, 1990.

20/ There do exist a few instances of truly innovative work by foreign affiliates in countries like India and Brazil, but these are rare and confined to a few industries like food, pharmaceuticals or transport equipment where local conditions differ significantly from those in other countries, and where import substitution policies have forced firms to find local substitutes to imported inputs.

21/ See OED, 1992.

22/ See Porter, 1990, and Chesnais, 1986.

23/ On the role of incentives, capabilities and institutions in shaping industrial success, see Lall, 1990.

24/ See Nelson and Winter, 1982, and Rosenberg, 1976.

25/ For a stimulating discussion see Freeman and Perez, 1988.

26/ See OED, 1992, for a brief analysis.

27/ See Lall, 1992.

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